Name _____

AP Bio Math Review

Surviving $C_iV_i = C_fV_f$

C_i = original concentration of the solution, before it gets watered down or diluted

C_f = final concentration of the solution, after dilution

V_i = volume about to be diluted

V_f = final volume after dilution

By drawing the "X" through the equal sign and filling in the formula with letters of a size permitted by the borders of the "X", it reminds you that :

for all dilution problems $C_i > C_f$, and $V_i < V_f$

It makes sense because to dilute, we add water. This ***increases*** the volume but ***lowers*** concentration.

Examples by Type:

Easiest: Joe has a 2 g/L solution. He dilutes it and creates 3 L of a 1 g/L solution.
How much of the original solution did he dilute?

A little trickier: Joe has 20 L of a 2 g/L solution. He diluted it, and created 3 L of a 1 g/L solution. How did he make such a solution?

Trickier still: Joe has 20 L of a 2 g/L solution. To this solution he adds 30 L.
What is the final concentration of the solution?

pH Reminder: pH = -log (H^+)

Each pH unit represents a TENFOLD difference in H^+ and OH^- concentrations!

- Acidic solution: pH < 7
- Neutral solution: pH = 7
- Basic solution: pH > 7

- As pH decreases, acidity increases.
  - The LOWER the pH, the more ACIDIC a substance is
- As pH increases, acidity decreases.
  - The HIGHER the pH, the more BASIC a substance is

- As **[H^+]** gets smaller,
  - Scientific notation exponents get MORE NEGATIVE
  - pH goes UP
- As **[H^+]** gets larger,
  - Scientific notation exponents get LESS NEGATIVE
  - pH goes DOWN

Problem 1: What happens to the concentration of hydrogen ions [H+] vs hydroxide ions [OH-] when the pH of a solution is changed from 9 to 4?

Problem 2: Rank the following from most acidic to least acidic.

pH= 10 pH = 6 pH = 2 $[H_3O^+] = 10^{-9}$ $[H^+] = 10^{-4}$ $[OH^-] = 10^{-6}$

Gibbs Free Energy

$\Delta G = \Delta H - T\,\Delta S$

What is Entropy? = a measurement of _____

When **Δ**S is positive this means there is _____

When **Δ**S is negative this means there is _____

What is **Δ**H? = a measurement of _____

When **Δ**H is positive this means the reaction is _____

When **Δ**H is negative this means the reaction is _____

What is Gibbs Free energy? = a measurement of _____

When **Δ**G is positive this means the reaction will happen _____

When **Δ**G is negative this means the reaction will happen _____

What happens to ΔG when ΔH goes up? WHY?

What happens to ΔG when ΔH goes down? WHY?

What happens to ΔG when T goes up? WHY?

What happens to ΔG when T goes down? WHY?

What happens to ΔG when ΔS goes up? WHY?

What happens to ΔG when ΔS goes down? WHY?

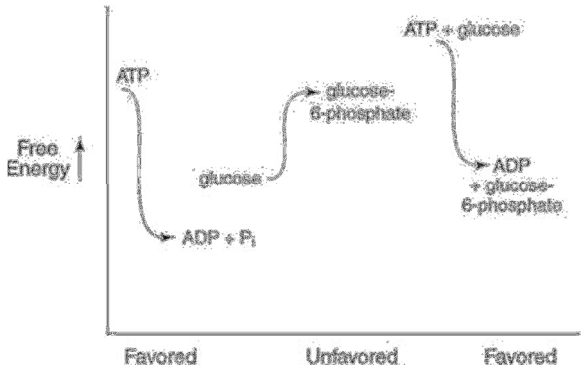
The hydrolysis of glucose-6-phosphate has ΔG = -4.0 kcal/mole (-16.5 kJ/mole) under standard conditions. Is this reaction

- Favored or unfavored
- Endergonic or exergonic
- Why?

Although the opposite reaction is unfavored, the phosphorylation of glucose occurs readily in the cell, catalyzed by the enzyme hexokinase, because of energy coupling. An unfavorable reaction is driven by a favorable one.

The phosphorylation of glucose has ΔG = +4.0 kcal/mole (which is endergonic) but the hydrolysis of ATP is exergonic with ΔG = -7.3 kcal/mole. What is the standard free energy change of the coupled reactions?

Coupling doesn't occur all by itself. In this example, if this experiment were set up so that the ATP would have to be hydrolyzed in one tube and the glucose phosphorylated in another, no coupling would be possible. Coupling can occur only when the partial reactions are part of a larger system. In this example, coupling occurs because both partial reactions are carried out by the enzyme hexokinase. In other cases, coupling can involve membrane transport, transfer of electrons by a common intermediate, or other processes. Another way of stating this principle is that coupled reactions must have some component in common.



The "orderliness" of your body is not favored by free energy. Explain (in terms of free energy and disorder) why you need to perform digestion?

Why does decomposition of a dead animal happen in terms of energy? What would happen if we increase temperature? Why do we freeze food?

Explain why plant cells need light to build sugar (in terms of energy).

Surface Area to Volume Ratios

1. Determine the surface area-to-volume ratio for a cube that has a side length of 1cm compared to a cube that has a side length of 3cm. Which one is more efficient in terms of diffusion?

2. Determine the surface area and volume the following 2 cells:

- Cell 1 (spherical) where the radius is 3 mm
- Cell 2 (rectangular) where the height is 0.5mm, length is 4mm, width is 2mm

	How to calculate Surface Area?	Surface Area	How to calculate Volume?	Volume
Cell 1				
Cell 2				

What is the surface area to volume ratio of each cell?

- Cell 1
- Cell 2

Which cell is more efficient and WHY?

3. When agar is prepared using phenolphthalein and sodium hydroxide, the solidified agar has a pink color. Phenolphthalein is an indicator that is colorless below pH 10 but pink at any pH greater than 10. In a diffusion experiment, a phenolphthalein agar sphere (2 cm diameter) and phenolphthalein agar cube (each side 2 cm long) were placed in a dilute 0.1M hydrochloric acid solution for 10 minutes. Both shapes were gently agitated every minute to ensure the areas adjacent to each shape did not reach equilibrium. After 10 minutes both the sphere and the cube were cut in half and the colorless agar depth was measured to be 5mm.

- Calculate the diffusion rate of the hydrochloric acid for each shape
- If the 2 shapes were actual living cells, does one shape offer an advantage for the diffusion of nutrients into and wastes out of the cell? Explain and justify your answer mathematically

Water and Solute Potentials

1. The value for Ψ in root tissue was found to be -3.3 bars. If you place the root tissue in a 0.1M solution of sucrose at 20°C in an open beaker, what is the Ψ of the solution, and in which direction would the net flow of water be?

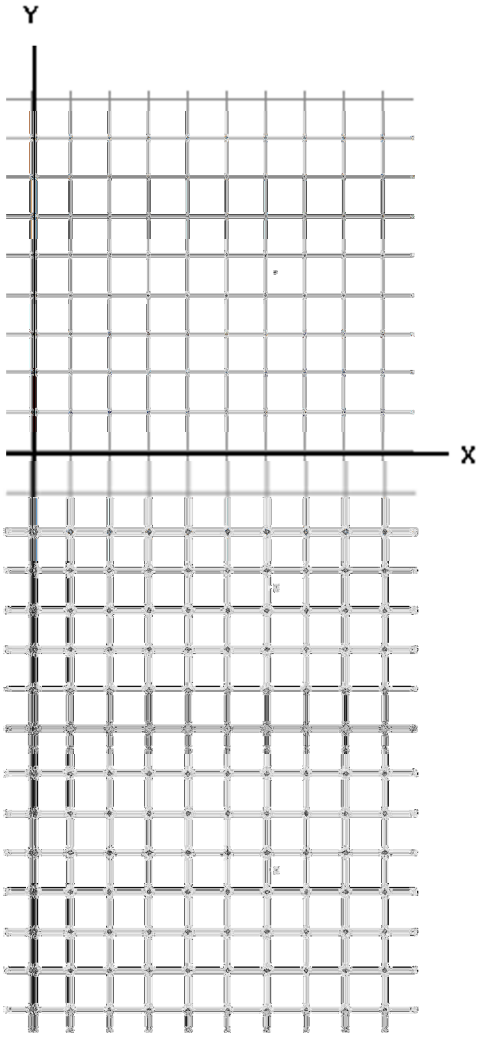
2. NaCl dissociates into 2 particles in water: Na^+ and Cl^-. If the solution above contained 0.1M NaCl instead of 0.1M sucrose, what is the Ψ of the solution, and in which direction would the net flow of water be?

3. A plant cell with a Ψ_S of -7.5 bars keeps a constant volume when immersed in an open-beaker solution that has a Ψ_S 0f -4 bars. What is the cell's Ψ_P?

4. At 20°C, a plant cell containing 0.6M glucose is in equilibrium with its surrounding solution containing 0.5M glucose in an open container. What is the cell's Ψ_P?

5. Water potential in potato cells was determined in the following manner. The initial masses of six groups of potato cores were measured. The potato cores were placed in sucrose solutions of various molarities. The masses of the cores were measured again after 24 hours. Percent changes in mass were calculated. The results are shown below. Graph these data. Then determine the apparent molar concentration (osmolarity) of the potato core cells.

Molarity of Sucrose in Beaker	Percent Change in Mass
0.0 M	18.0
0.2	5.0
0.4	-8.0
0.6	-16.0
0.8	-23.5
1.0	-24.0



Population Growth

Example 1: There are 300 falcons living in a certain forest at the beginning of 2013. Suppose that every year there are 50 falcons born and 30 falcons that die.

a. What is the **population growth rate** (include units)? Interpret the value.

b. What is the **per capita growth rate** of the falcons over a year? Interpret the value.

c. Complete the table by determining the total population size each year from 2013 to 2018. Be sure to show your work.

Year	Population
2013	
2014	
2015	
2016	
2017	
2018	

d. Find the **average rate of change** for the falcon population from 2013 to 2018.

Example 2: Kentwood, Michigan had a population of 49,000 in the year 2013. The infrastructure of the city allows for a carrying capacity of 60,000 people. $r_{max} = .9$ for Kentwood.

a. Is the current population above or below the carrying capacity? Will the population increase or decrease in the next year?

b. What will be the **population growth rate** for 2013 (show your work and include units)?

c. What will be the **population size** at the start of 2014?

d. Complete the following table by determining the population size and growth rate each year. Be sure to show your work.

Year	Population size	Population growth rate
2013		
2014		
2015		
2016		
2017		

e. What happened to the population growth rate as the population size approached carrying capacity?

Hardy Weinberg

1. If 98 out of 200 individuals in a population express the recessive phenotype, what percent of the population would you predict would be heterozygotes?

2. Your original population of 200 was hit by a tidal wave and 100 organisms were wiped out, leaving 36 homozygous recessive out of the 100 survivors. If we assume that all individuals were equally likely to be wiped out, how did the tidal wave affect the predicted frequencies of the dominant and recessive alleles in the population?

3. Let's say that brown fur coloring is dominant to gray fur coloring in mice. If you have 168 brown mice in a population of 200 mice, what is the frequency of each genotype?

Chi Square

1. At a particular high school, students can choose to enter one of three doors. Custodians noticed that door #3 was always getting broken and suggested that more students use that door because it has a hands-free opener. Science minded students counted the number of students entering each door to see if the custodians were right.

- Door #1 had 60 students enter
- Door #2 had 66 students enter
- Door #3 had 80 students enter.

Were the custodians right? Use Chi Square analysis to support your answer.

2. In peas, yellow seeds (A) are dominant over green seeds (a). In a cross between two plants that are both heterozygous for seed color, the following was observed:

- Yellow = 4400
- Green = 1624

Does the data fit the predicted ratio? Use Chi Square analysis to support your answer.

3. Color blindness is a sex-linked trait in Bombats. A female who is a carrier of the color blind allele mates with a male who is color blind. The phenotypes of their offspring are:

- Normal female = 132
- Color blind female = 124
- Normal male = 126
- Color blind male = 136

Does the data fit the predicted ratio? Use Chi Square analysis to support your answer.

4. In one particular species of plant, purple flowers (P) are dominant over red flowers (p) and long pollen grains (L) are dominant over round pollen grains (l). After crossing true breeding plants that have purple flowers and long pollen grains with true breeding plants that have red flowers and round pollen grains, the resulting dihybrids (PpLl) were then crossed. Of the resulting 381offspring, 284 had purple flowers and long pollen grains, 21 had purple flowers and round pollen grains, 21 had red flowers and long pollen grains, and 55 had red flowers and round pollen grains. Determine whether or not the genes for flower color and pollen grain shape are linked or unlinked. Use Chi Square analysis to support your answer.